Field Investigation of Georgia Tektites and Description of New Specimens

By

Elbert A. King, Jr.

Department of Geological Sciences, Harvard University

Reprinted from the "Georgia Mineral Newsletter"—VOL. XV, NO. 3-4, WINTER 1962.

Field Investigation of Georgia Tektites and Description of New Specimens

By

Elbert A. King, Jr.

Department of Geological Sciences, Harvard University

Field investigation of the tektite occurrence in Dodge County, Georgia, was conducted by the writer during the latter part of the summer of 1962. This work included the geologic mapping of Dodge County and stratigraphic investigations that will be published separately. Three new tektites were found and another previously undescribed specimen was obtained from a local resident.

The three tektites found by the writer and his field assistant were lying on the surface of Pleistocene (?) sand and gravel. Pleistocene (?) sand and gravel is the youngest stratigraphic unit in Dodge County, and unconformably overlies Miocene (?) clay and sandy clay. The few other Georgia tektites, for which there is any reliable or exact locality information, were found in stratigraphically similar situations. The tektite found by the writer (DGA-4, Plate II, Nos. 1 & 2) was in surface gravel (Figure 1) on an outcrop (Figure 2) 3.7 miles N 23° W of the main highway intersection at Eastman, Georgia. A thorough search of the locality within a radius of about 200 yards failed to produce any additional specimens. This locality is approximately 0.8 mile N 10° W of the location where Mr. W. S. Hambrick of Eastman, Georgia, found the largest known Georgia tektite. The new locality is near an old house site, and, in addition to vein quartz and ferruginous sandstone pebbles that compose most of the surface gravel (Table I), the immediate area contains abundant man-made glass fragments, crockery shards, and rusted iron. Mr. Will Sellers of Helena, Georgia, the writer's field assistant, found two tektites in a county road approximately 3.2 miles S 16° W (DGA-3, Plate I, Nos. 5 & 6), and 3.7 miles S 20° W (DGA-2, Plate I, Nos. 3 & 4) of the town center of Chester, Georgia. The larger of these two specimens (DGA-2) was first seen and recognized by Mr. Sellers while he and the writer were driving along in low gear looking out a truck window for tektites in the gravels at the side of the road. Although the gravel and sand in the county road where the tektites were found appears to be identical with that in the adjoining fields, it is possible that the tektites were brought to the places where they were found along with gravel and sand hauled in for road surface. It is a common practice to "soil" the roads in Dodge County, although this material is rarely hauled very far. The gravel at the localities where the new specimens (DGA-4, and DGA-2 & 3) were found is similar in size and composition (Table I). Ferruginous sandstone pebbles are the most abundant rock type in the gravel, giving the ground surface a reddish brown color. The second most abundant rock type is vein quartz, derived from the piedmont to the north and northwest. The provenance of the ferruginous sandstone pebbles is uncertain as this rock type was seen in place in the Pleistocene (?) sand and gravel, and also in the underlying Miocene (?) sandy clay.

The stratigraphic association of the tektites with the Pleistocene (?) sand and gravel leaves the following possibilities as to the age of the Georgia tektite shower:

1. The tektites may have fallen onto the present surface and thus be younger than the Pleistocene (?) sand and gravel on which they are found.

	DGA-4		DGA-2 & 3	
	Quartz	Ferruginous Sandstone	Quartz	Ferruginous Sandstone
Number of Pebbles	322	678	248	752
Max. diam. of largest pebble	29 mm.	18 mm.	21 mm.	24 mm.
Sample mean size	8.2 mm.		6.0 mm.	

Table I.—1000 pebble counts of the greater than 4 mm. size fraction of the gravel associated with the new tektite finds.

2. The tektites may have fallen into the Pleistocene (?) sand and gravel during its deposition and now be weathering from it.
3. The shower could have fallen on the erosion surface at the base of the Pleistocene (?) sand and gravel, and thus be older than the Pleistocene (?) unit and younger than the underlying Miocene (?) rocks, and now be weathering from the Pleistocene (?) sand and gravel into which the tektites have been reworked.
4. The tektites could have been reworked from Miocene (?), Oligocene, Eocene or older rocks to the north and northwest and transported with the Pleistocene (?) sand and gravel to Dodge County where the tektites are now weathering from the Pleistocene (?) unit.

Potassium-argon age determinations by Reynolds (1960) and Gentner and Zähringer (1961) give the age of the Georgia tektites as 32 ± 1 million years. Argon diffusion may have increased the potassium-argon ratio, and the age determined by this method should be regarded as a minimum age. This supports the last of the four above listed possibilities.

The long axis of the aerial distribution of the Georgia tektite localities is perpendicular to the strike of the underlying rock units, but is parallel to the major drainage direction. Crossbedding in the Pleistocene (?) sand and gravel generally dips to the south and southeast. The presence of quartz pebbles in the Pleistocene (?) unit that have been derived from the crystalline rocks to the north and northwest also supports the hypothesis that the major drainage direction during the Pleistocene (?) was probably very close to the present drainage direction.

The only objection to the hypothesis that the tektites may have been reworked from older units has been raised by Furcron (1961, p. 117), who believes that the tektites are too fragile to withstand reworking and transport. It is true that the tektites are less resistant to breakage and abrasion than the quartz pebbles in the Pleistocene (?), but the ratio of gravel to sand in the Pleistocene (?) unit is quite small. The tektites might very well survive the short distance of transportation from Oligocene or Eocene rocks (10 to 15 miles), especially if cushioned by a large dilution of significantly smaller size fractions.*

Because it is possible that tektites may have been derived from terrestrial rocks, samples were collected from two stratigraphic units that the writer thought might have similar chemical compositions to the tektites. The samples were "grab" samples from a single exposure of each unit, but each unit appears to be fairly homogenous. The unfossiliferous Miocene (?) sandy clay underlies almost all of Dodge County beneath the Pleistocene (?) sand and gravel. The Upper Eocene Twiggs Clay is a marine bentonite that has been reported to be as much as 40 feet thick (Pickering, 1961, p. 84) and is exposed approximately 10 miles north and northwest of Dodge County. The results of the two analyses (Table II) were recalculated to 100% on a water and ignition loss free basis. This is believed justified in that any process which could produce the tektites probably also produced enough heat to drive off water and combustible material that may have been present in the parent material. There is very little similarity between either the Miocene (?) sandy clay or the Twiggs Clay samples and the tektite analysis reported by Clarke and Carron (1961). On the basis of these analyses, it is very doubtful that the Georgia tektites could have been derived from either of these units as the parent material.

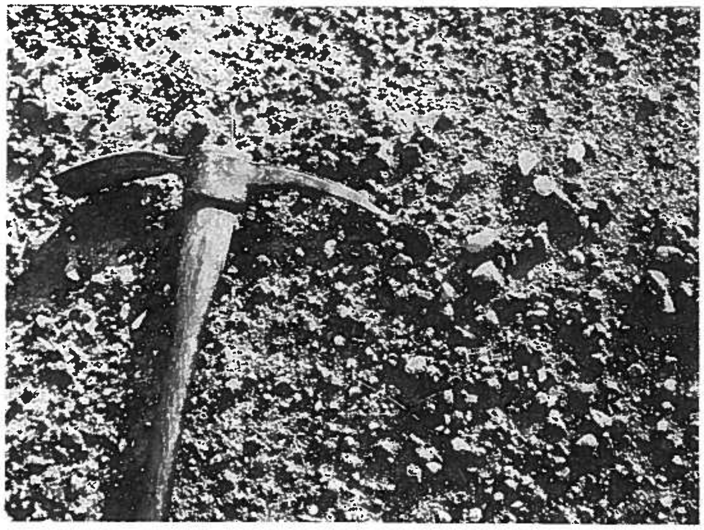


Figure 1. Tektite (DGA-4) in surface gravel 3.7 miles N23° W of the main highway intersection at Eastman, Georgia. The gravel is almost entirely vein quartz and ferruginous sandstone. This photograph was taken before the specimen had been picked up for examination, and is exactly as it was first seen by the writer. The tektite is at the end of the pick point.

An attempt was made to catalog all of the known tektites from the Georgia Coastal Plain (Table III). The new finds bring the total number of specimens from this area to 21. Unfortunately, 2 of these have been lost.

Table II.—Chemical analyses of two samples from rock units in or near the Dodge County tektite area.

	Miocene (?) sandy clay[a]	Twiggs Clay[b]	Miocene (?) sandy clay[c]	Twiggs Clay[c]	Georgia Tektite (USNM #1396)[d]
SiO_2	65.72	63.44	73.70	75.15	80.54
Al_2O_3	15.56	13.79	17.49	16.33	11.21
Fe_2O_3	4.50	3.65	5.60	4.33	0.33
FeO	nd	nd	....	....	2.40
CaO	1.30	1.38	1.46	1.63	0.61
MgO	0.87	1.56	0.98	1.85	0.65
MnO	0.00	0.00	0.00	0 00	0.05
Na_2O	0.42	0.45	0.47	0.53	1.16
K_2O	0.56	0.16	0.63	0.19	2.38
H_2O-	5.20	10.43	....	....	none
H_2O+			....	....	0.02
TiO_2	0.06	0.05	0.07	0.06	0.43
P_2O_5	0.00	0.00	0.00	0.00	....
ign. loss	5.80	5.21	....	....	....
undet.	0.01		0.01		
totals	100.12	100.00			99.78

a—Analysis by Dr. L. H. Turner, Chief Chemist, Georgia Geological Survey. Sample from base of road cut on State Highway 257 one and one-half miles east of Yonkers, Dodge County.

b—Analysis by Dr. L. H. Turner, Chief Chemist, Georgia Geological Survey. Sample from road cut 2 miles west of Jeffersonville on road to Bullard High School, Twiggs County.

c—Analyses a & b recalculated to 100% deleting water and ignition loss.

d—From Clarke and Carron (1961).

**Editor's Note*: *This comment repeats and is intended to express more completely certain opinions outlined in the paper by Furcron (1961), wherein from personal observations and geologic work of others, he favors a Pliocene or Pleistocene age for the sand and gravel upon which the tektites are found and which were generally regarded as Miocene in age. The possibility that the tektites have been transported was not excluded in Furcron's article but his objection to transportation because of the fragile nature of the tektites is only one of the possible observations which may be raised against it.*

With current age determinations of formation of the tektites (32 ± 1 million years) in order to explain their present position, it will be necessary to invoke a transportation theory for them, or revise downward the present age determinations, or assume that these objects spent millions of years somewhere in space before they fell upon the present surface of Dodge County. In accepting the transportation theory, one may go far enough north and select a limestone which has the proper age as determined for the tektites and infer that it is their source rock or one may bring them from Tuscaloosa rocks of Upper Cretaceous age which contain gravels similar in appearance to the tektite gravels; or, if one wishes, it is possible to continue on up into the Piedmont for several hundred miles and bring them in from that source which was the original source of the Cretaceous gravels. Probably the gravels did come from the Upper Cretaceous with an original Piedmont source. If geomorphological considerations would permit it, and their present surface features could be established as produced by concussion during transportation, and only those fragile glasses could "take it", it would be tempting to speculate that they came in with the gravels even if, so far, all have been found on the surface.

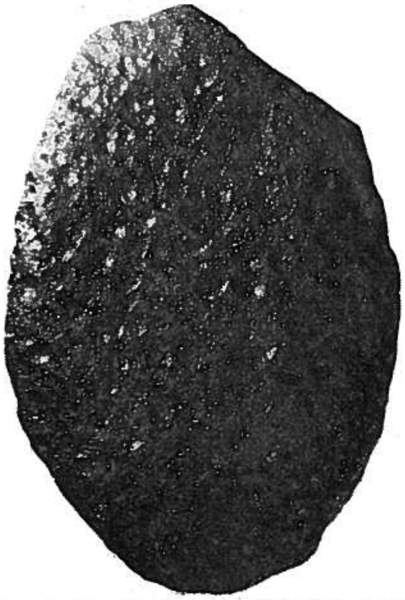
Not much detailed geomorphology has been done in the southeast. Writers quoted by Furcron (1961) regard the large valleys of Oconee and Ocmulgee Rivers as preglacial, thus unless they were not clogged during glacial times to the elevation of the upper land surface, they could not have been responsible for bringing down tektites in glacial times; and if these valleys were so clogged or did not exist, it is strange that with the exception of the one Irwin County find, all of the tektites thus far have been found in Dodge County, although Dodge is only one of numerous counties between these two rivers. In fact, if the latter condition occurred, one also would expect to find tektites in counties west of the Ocmulgee and east of the Oconee River as well. If during the Pleistocene the large valleys were filled so that sands and gravels could be swept over the higher land surfaces of Dodge County, Eocene and Oligocene rocks would be buried, thus an unlikely source of tektites. Also, should adequate physical evidence be presented to indicate some transportation, how may that fact set a positive distance limit which will fit the amount of abrasion assumed to fit the required degree of transportational wear which took place as the tektites were transported to their present positions? Until georgiaites are located IN a specific source rock this specious controversy can continue per se indefinitely.

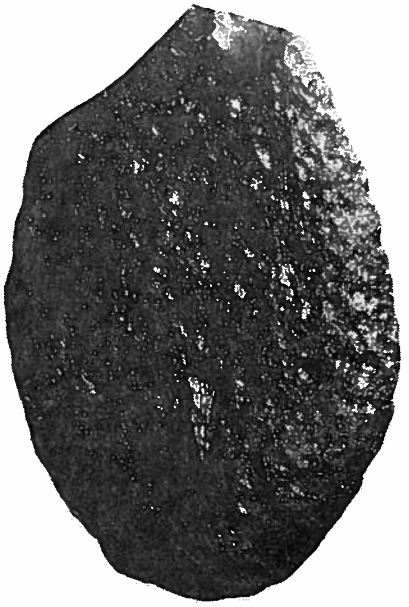
Thus, it is believed by Furcron that numerous aspects of approach in addition to the actual physical appearance of the tektites will be necessary before a secure transportation theory can be established and without a transportation theory, these georgiates could have an on-earth-age of Pliocene to Pleistocene or even post-Pleistocene.

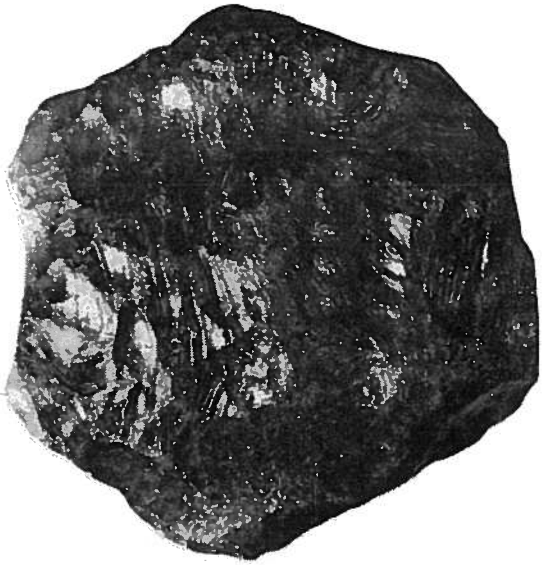
In Australia, Baker states (article in this number of the Newsletter), that it has not been established that age-of-formation and age-on-earth have necessarily to be one and the same event; also, that the australites have been on earth no more than 20,000 years and more likely approximately 5,000 years.

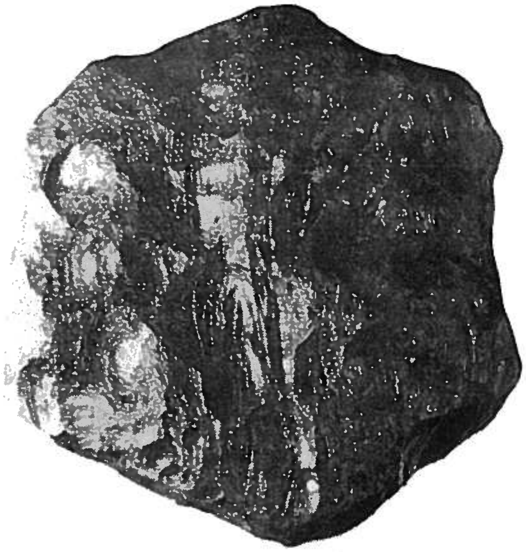
In summary, the present accepted age of origin of georgiates to age on earth is anomalous, and the solution of this anomaly may come from more field investigation and from additional physical and geochemical work — A. S. Furcron

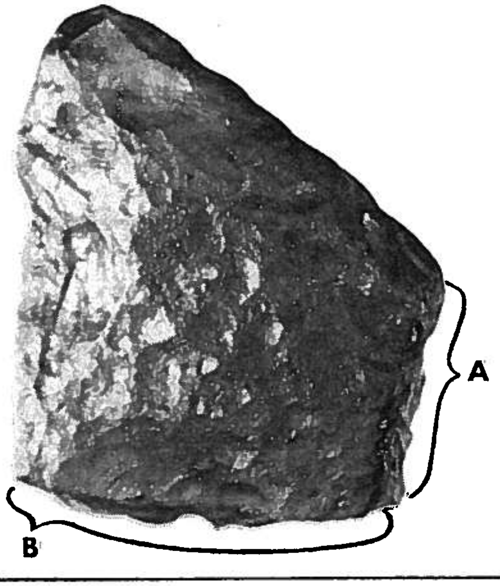
Plate I


1


2


3


4



5

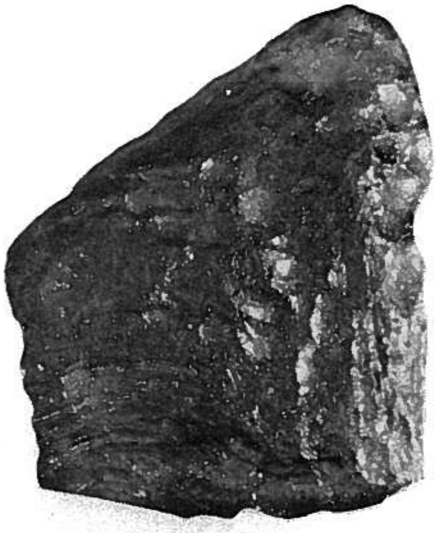
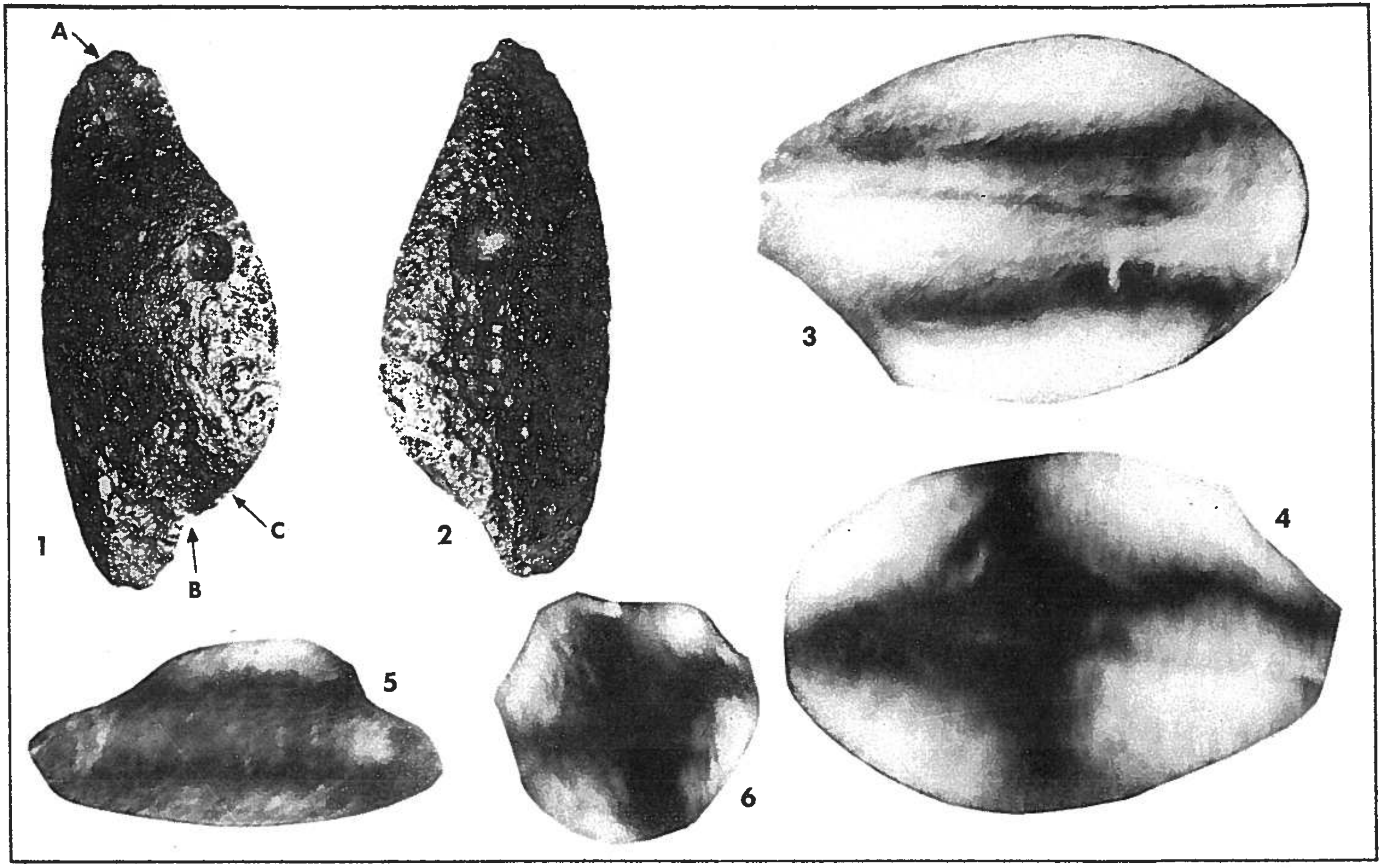

6

Plate II



PLATES

Plate I

No. 1 & 2—Georgia tektite (DGA-1), weight 25.945 grams, front and back views, 1.4X.

No. 3 & 4—Georgia tektite (DGA-2), weight 7.507 grams, front and back views, 2.9X. This specimen was found by Mr. Will Sellers while looking out the window of a moving truck.

No. 5 & 6—Georgia tektite (DGA-3), weight 2.609 grams, front and back views, 3.4X. Surface A is an old break that has since been etched. Surface B is a recent unetched break.

Plate II

No. 1 & 2—Georgia tektite (DGA-4), weight 6.633 grams, front and back views, 1.8X. A and B are recent chips, C is an old chip that is etched.

No. 3—Georgia tektite (DGA-1) in crossed nicols, isogyres at maximum separation. The light spot seen in one isogyre is the effect of strain around a large lechatelierite particle. 1.4X.

No. 4—Georgia tektite (DGA-1) in crossed nicols, crossed isogyres, 1.4X.

No. 5—Georgia tektite (DGA-4) in crossed nicols, isogyres at maximum separation, 1.4X.

No. 6—Georgia tektite (DGA-2) in crossed nicols, figure is uniaxial, 1.4X.

Table III.—Catalog of Georgia Tektites.[a]

Found by	Locality	Length (cm.)	Max. Width (cm.)	Max. Thickness (cm.)	Weight (gm.)	Sp. Gr.	Owner
L. J. Allen	Plainfield	2.3	2.1	1.2	7.05	2.31	L. J. Allen
L. J. Allen	Plainfield	3.7	3.4	1.1	16.30	2.34	L. J. Allen
L. J. Allen	Plainfield	4.6^b	3.2^b	1.0^b	......	......	L. J. Allen
L. J. Allen	Plainfield	3.2^b	2.6^b	0.8^b	......	......	L. J. Allen
L. J. Allen	Plainfield	......	......	......	23.00	2.33	S. Wolfson
L. J. Allen	Plainfield	3.5	2.9	0.9	11.2	......	G. A. Bruce
L. J. Allen	Plainfield	......	......	......	......	......	specimen lost
Dewey Horne	near Empire	6.5	3.5	1.0	25+	2.33	U.S.N.M.
Dewey Horne	near Empire	3.3	2.7	1.4	13.4	2.32	U.S.N.M.
Mrs. T. Hogg	near Empire	3.5^b	......	......	......	......	Mrs. T. Hogg
*unknown	Osierfield (?)	4.7	4.4	0.6	17.8	......	Ga. Geol. Surv.
Mrs. E. Register	near Empire	4.2^b	3.7^b	0.8^b	......	......	Mrs. E. Register
Mrs. E. Register	near Empire	5.59	3.62	1.17	25.945	2.33	E. A. King, Jr.
R. S. Crosby	Roddy	7.0^c	4.5^c	1.0^c	......	......	specimen lost
unknown	near Roddy	3.5^b	3.5^b	0.7^b	......	......	C. M. Bellflower
W. S. Hambrick	near Eastman	5.1	4.3	1.6	36.5	2.32	W. S. Hambrick
Will Sellers	Jay Bird Springs	4.3	2.1	1.4	14.58	2.33	Ga. Geol. Surv.
Will Sellers	Jay Bird Springs	2.8	1.7	0.45	2.60	2.35	A. J. Cohen
Will Sellers	near Chester	2.70	2.61	1.09	7.507	2.32	E. A. King, Jr.
Will Sellers	near Chester	2.27	1.80	0.72	2.609	2.35	E. A. King, Jr.
E. A. King Jr.	near Eastman	4.15	1.86	0.89	6.633	2.36	E. A. King, Jr.

a—Taken in part and modified from Clarke and Henderson (1961).
b—Estimated by eye or from photographs by the writer.
c—Estimated by Mr. R. S. Crosby.

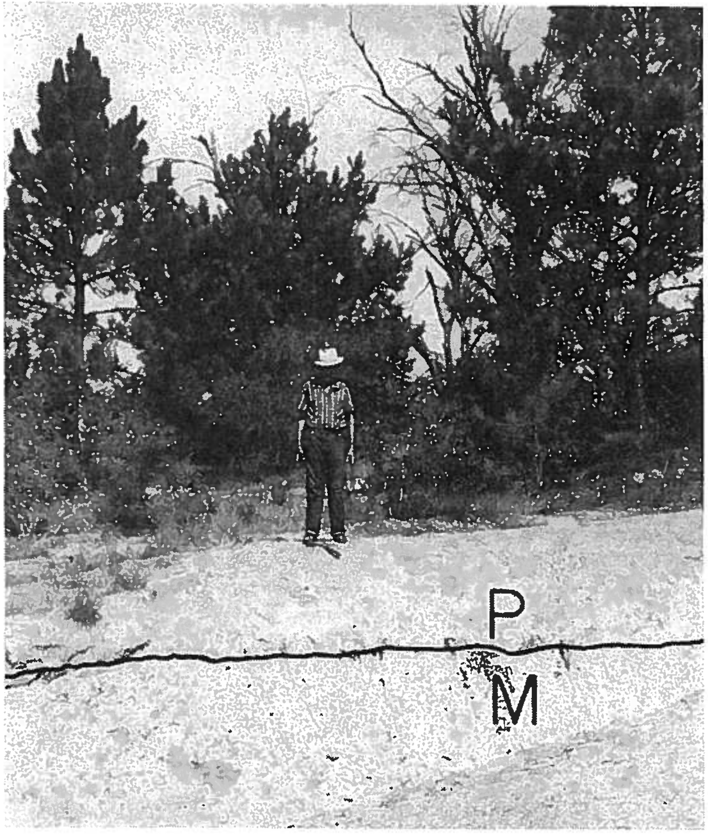


Figure 2. Mr. Will Sellers standing at the locality where the tektite DGA-4 was found. The pick at Mr. Seller's feet marks the exact spot. Unit P is Pleistocene (?) sandy clay and sand. Unit M is Miocene (?) clay and sandy clay. These two units are separated by an erosional unconformity. There is a thin veneer of surface gravel.

The writer and Mr. Sellers spent very little time simply looking for tektites because of pressing time requirements for mapping and stratigraphic work. It seems unlikely that 3 new specimens should be found with a minimum of effort during a few weeks, considering that only 18 specimens had been found in the previous years, unless the Georgia tektites are more common than was previously believed.

DESCRIPTION OF SPECIMENS

DGA-1 (Plate I, Nos. 1 & 2; Plate II, Nos. 3 & 4) has the appearance of a flattened drop. The unetched breaks at the smaller end of the specimen (Plate I, Nos. 1 & 2) were reportedly made by a jeweler who examined the stone. The largest bubble in the specimen is approximately 0.3 mm. diameter, all of the bubbles are spherical or very nearly so. The bubble content of the specimen varies considerably. The average bubble content is approximately 200 bubbles per cubic centimeter, individual bubbles having a mean diameter of approximately 0.1 mm. Lechatelierite particles are numerous, and bubble swarms around these particles are common. The specimen shows a very strong biaxial (-) interference figure in crossed nicols (Plate II, No. 3), secondary strain patterns can be seen around lechatelierite particles. The long streak between the isogyres (Plate II, No. 3) is the result of strain across a boundary adjoining two layers of differing composition. Most of the "flow structure" in the specimen is roughly parallel to the long axis, relatively smooth and uncontorted. This specimen has subsequently been cut into several pieces. After cutting, the largest piece, roughly the 2/3 of the specimen with the broken end, still shows a strong biaxial interference figure. The separation of the isogyres is not quite as great as before cutting, and the isogyres are not quite as symmetrical as before cutting. The uniaxial or biaxial character of the interference figure is probably a function of the two dimensional shape normal to the line of view as well as the original strain distribution. A 4+ gram fragment of this specimen has been sent to Jun Ito for chemical analysis. One tiny fragment will be semi-quantitatively spectographically analyzed. A small fragment has been furnished to Dr. C. C. Schnetzler for Sr/Rb

---

**Editor's Note: This tektite was illustrated upon the front page of Science 24 February 1961. It was donated to the Georgia Geological Survey Nov. 1955 by Messrs. C. M. Copeland and Milton Hopkins of Fitzgerald, Ga., who report that it was found by Hardy Scott in the summer of 1955 about 3 miles southwest of Osierfield, Irwin County.*

and Sr^{87}/Sr^{86} work. The Georgia Geological Survey has been supplied with a plaster cast of the specimen. The exact locality where this specimen was found is unknown, but probably near Empire. The specimen is transparent, golden olive green in transmitted light, but appears to be almost opaque dark olive green in reflected light. Specific gravity (bulk) = 2.33. The refractive index varies with each individual layer in the specimen. Measurements of refractive index about the periphery of the specimen and from small chips are: 1.488, 1.490, 1.484, 1.485.

DGA-2 (Plate I, Nos. 3 & 4; Plate II, No. 6) is roughly hexagonal in outline, and appears to have several old breaks that are now etched over about the periphery of the specimen. The depth of etching on these old breaks is only slightly less than that over the rest of the surface. The largest bubble in this specimen is about 0.2 mm. in diameter. All bubbles are very nearly spherical, average about 0.1 mm. diameter, and some are seen in swarms about lechatelierite particles which are numerous. This specimen has a strong uniaxial (-) interference figure in crossed nicols (Plate II, No. 6). The "flow structure" is very distinct on the surface of this specimen where it has been brought out by differential natural etching. Color is golden olive green, slightly darker than DGA-1 in transmitted light, same color as DGA-1 in reflected light. Specific gravity is 2.32. Refractive indices measured about the periphery of the specimen are: 1.484, 1.487, 1.485, 1.488.

DGA-3 (Plate I, Nos. 5 & 6) is a fragment of a larger tektite. Surface A (Plate I, No. 5) is an old break that is now well etched. Surface B is a recent break that is completely unetched which may have been produced by cars running over the specimen. The immediate area was searched, but no other fragments were found. There are very few bubbles in this sample, the largest approximately 0.07 mm. and all are spherical. Lechatelierite particles are very small and scarce. Color is golden green in transmitted light, very transparent, and olive green in reflected light. Specific Gravity is 2.35. Refractive indices of this specimen are not as variable as DGA-1 or 2, mostly close to 1.486. The specimen shows a weak biaxial (-) interference figure in crossed nicols.

DGA-4 (Plate II, Nos. 1, 2, and 5) has the appearance of an assymetrical flattened drop. There are recent chips at points A and B (Plate II, No. 1), and there appears to be an old chip that is etched at point C. The old chip at C is partly obliterated by the newer chip at B. The largest bubble is approximately 0.2 mm., and all bubbles are very nearly spherical. Bubble density per volume is about the same as DGA-1. There are several lechatelierite particles that have bubble swarms around them. The tektite exhibits a strong biaxial (-) figure in crossed nicols (Plate II, No. 5). Color is the same as that of DGA-1. The "flow structure" tends to be parallel to the length of the specimen. Refractive indices measured about the periphery of the specimen are: 1.485, 1.484, 1.488. Specific gravity is 2.36.

CONCLUSIONS

The age of the Georgia tektite shower cannot be determined in Dodge County on the basis of stratigraphy. The association of the Georgia tektites with Pleistocene (?) sands and gravels that unconformably overlie older units leaves the age of the tektites an open question. The older age indicated by potassium-argon dates is consistent with the stratigraphic possibilities.

The Georgia tektites are probably more numerous than was previously believed.

ACKNOWLEDGEMENTS

The writer is indebted to the State of Georgia whose Department of Mines, Mining and Geology supported the field work in Dodge County. Harvard University furnished the writer with a Summer Scholarship which was used in part for expenses connected with this investigation. Discussions of the problem with Dr. A. S. Furcron were very helpful to the writer. Mr. Will Sellers of Helena, Georgia, is deserving of special thanks as he generously donated his time and efforts as field assistant, as well as donating for study the two tektites that he found.

REFERENCES

Clarke, R. S., Jr. and Maxwell K. Carron (1961) Comparison of tektite specimens from Empire, Georgia, and Martha's Vineyard, Massachusetts: Smithsonian Misc. Collections 143, no. 4, p. 18, 6 pls.

Clarke, R. S., Jr. and E. P. Henderson (1961) Georgia tektites and related glasses: Georgia Mineral Newsletter XIV, no. 4, winter 1961, p. 90-114, 14 pls.

Furcron, A. S. (1961) Geologic age of the tektite shower and its associated rocks of the Georgia Coastal Plain: Georgia Mineral Newsletter XIV, no. 4, winter 1961, p. 115-119.

Gentner, W. and J. Zahringer (1960) The potassium-argon ages of tektites: Jour. Geophys. Research 65, p. 2492.

Pickering, S. M., Jr. (1961) Geology of iron ore deposits of the Perry Quadrangle, Georgia: Georgia Mineral Newsletter XIV, no. 4, winter 1961, p. 83-90.

Reynolds, J. H. (1960) Rare gases in tektites: Geochem. et Cosmochem. Acta 20, p. 101-114.